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DIGITAL STRATEGY ADAPTATION IN UNIVERSITY-BASED TECHNO PARKS: A SYSTEMATIC REVIEW OF INNOVATION AND ENTREPRENEURIAL ECOSYSTEMS

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ABSTRACT

This study presents a systematic literature review examining the strategic adaptation of digital technologies within university-based Techno Parks, with a particular focus on their role in fostering sustainable innovation and entrepreneurial ecosystems. Drawing upon 127 peer-reviewed articles published between 2019 and 2025, the review employs thematic synthesis guided by the PRISMA 2020 framework. The findings reveal that digital strategies particularly artificial intelligence, cloud computing, and big data analytics are increasingly central to the transformation of academic innovation environments. However, implementation challenges persist, including infrastructural limitations, digital skill gaps, and organizational inertia. Grounded in the Resource-Based View (RBV) and Dynamic Capabilities Theory, this study identifies key enablers such as agile governance, stakeholder collaboration, and absorptive capacity. By integrating digital transformation with sustainability imperatives, the study contributes to the theoretical discourse on innovation ecosystems and offers actionable insights for higher education leaders and policymakers. The review underscores the strategic potential of Techno Parks as digitally empowered platforms for advancing the United Nations Sustainable Development Goals (SDGs). Despite the growing literature on digital transformation in higher education, existing studies remain fragmented and largely technology-specific, with limited integration of theoretical frameworks such as the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT). This study addresses this gap by conducting a systematic literature review of 127 peer-reviewed articles published between 2019 and 2025. By synthesizing these findings through RBV and DCT, the review not only highlights prevailing digital strategies and associated challenges but also demonstrates how Techno Parks strategically adapt digital resources to advance sustainable innovation. The novelty of this work lies in its theoretical integration, its mapping of knowledge gaps in prior research, and its identification of new insights for higher education institutions, thereby providing a strong justification for the need and timeliness of this study.

Keywords: *Digital Transformation, Techno Parks, Higher Education Institutions, Innovation Ecosystems, Sustainable Development Goals*

1. INTRODUCTION

In the context of accelerating technological disruption and global sustainability challenges, higher education institutions (HEIs) are increasingly positioned as pivotal actors in driving innovation, economic development, and societal progress. Among the institutional mechanisms that facilitate this role, university-based Techno Parks have emerged as strategic platforms for translating academic research into market-oriented innovations. These entities operate as dynamic ecosystems, integrating academic expertise, entrepreneurial initiatives, and industrial partnerships to foster knowledge transfer, startup incubation, and regional competitiveness [1].

The proliferation of digital technologies such as artificial intelligence (AI), big data analytics, cloud computing, and the Internet of Things (IoT) has fundamentally reshaped the operational and strategic landscape of Techno Parks [2] – [5]. Digital transformation is no longer a supplementary enhancement but a core strategic imperative for HEIs seeking to remain agile, inclusive, and responsive to the demands of the knowledge economy. Moreover, the integration of digital strategies within Techno Parks directly contributes to the achievement of multiple United Nations

Sustainable Development Goals (SDGs), including SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure), and SDG 17 (Partnerships for the Goals) [6].

Despite the increasing relevance of digital transformation in academic innovation ecosystems, the existing literature remains fragmented and lacks a comprehensive theoretical synthesis. Most prior studies focus on isolated technological implementations or context-specific outcomes, without systematically examining the strategic adaptation of digital technologies through robust theoretical lenses. Notably, there is a significant gap in research that integrates the Resource-Based View (RBV) and Dynamic Capabilities Theory to analyze how university-based Techno Parks leverage internal resources and adapt to external changes to achieve sustainable innovation outcomes [7], [8].

To address this gap, the present study conducts a systematic literature review (SLR) of 127 peer-reviewed articles published between 2019 and 2025. Guided by the PRISMA 2020 framework [9] and employing thematic synthesis, the review aims to identify prevailing digital strategies, implementation challenges, and critical success factors within university-based Techno Parks. The analysis is anchored in RBV and Dynamic Capabilities Theory, offering a robust conceptual foundation for understanding strategic digital adaptation in higher education contexts.

The need for this study is underscored by two critical factors. First, the acceleration of digital disruption and the growing policy emphasis on innovation-driven economies require higher education institutions to strategically adapt their Techno Parks. Second, prior research remains fragmented: while some studies explore isolated technologies (e.g., AI in research commercialization), others analyze specific regional contexts without offering a broader theoretical synthesis.

Table 1 maps representative prior studies in this domain. While these works provide valuable insights into innovation ecosystems, collaboration models, and barriers to digital transformation, they remain limited in scope. Most are either technology-specific (e.g., AI, IoT), context-specific (e.g., SMEs, national cases), or lack theoretical integration (RBV and DCT). Furthermore, few explicitly connect digital strategies within Techno Parks to sustainable development goals. This critique highlights the novelty and necessity of the present study.

Table 1: Representative prior studies on digital strategy in university-based Techno Parks and their limitations.

Author	Focus of Study	Key Findings	Limitations / Critique
Uddin et al. [10]	Higher Education in innovation ecosystems	Highlighted the role of HEIs in fostering innovation ecosystems	Did not analyze digital transformation processes or theoretical frameworks (RBV/DCT)
Mineiro et al. [11]	Quadruple/Quintuple helix in science & technology parks	Emphasized multi-stakeholder collaboration	Lacked systematic analysis of digital strategies and sustainability linkages
Singun [12]	Barriers to digital transformation in HEIs	Identified institutional, technical, and cultural barriers	Narrow focus on barriers; did not connect to broader innovation ecosystems or SDGs
Khatter [13]	Strategic change and resource-based theory in digital industries	Showed RBV relevance to digital adaptation	Focused on TV industry, not HEIs; did not extend to Techno Parks
Nguyen & Le [14]	SMEs and digital transformation using DCT	Demonstrated importance of dynamic capabilities for adaptation	Context limited to SMEs; findings not transferable to HEI-based Techno Parks

Research Questions

To guide the review and ensure analytical clarity, the following research questions are posed:

RQ1: What digital strategies are currently employed within university-based Techno Parks to foster innovation and sustainability?

RQ 2: What organizational, technological, and ecosystem-related challenges hinder the effective implementation of these digital strategies?

RQ 3: How do the Resource-Based View and Dynamic Capabilities Theory explain the strategic adaptation of digital technologies in Techno Parks?

RQ 4: In what ways do digital strategies within Techno Parks contribute to the achievement of Sustainable Development Goals (SDGs)?

By addressing these questions, the study contributes to the scholarly discourse on digital transformation in higher education and provides actionable insights for academic leaders, policymakers, and practitioners seeking to build resilient, future-ready innovation ecosystems.

2. THEORETICAL FRAMEWORK

The strategic adaptation of digital technologies within university-based Techno Parks is a multifaceted process that requires a robust theoretical foundation to understand the dynamic interplay between institutional capabilities, technological change, and innovation outcomes. This study is grounded in two complementary theoretical perspectives: the Resource-Based View (RBV) and Dynamic Capabilities Theory, both of which offer valuable insights into how organizations can leverage internal resources and adapt to external environmental shifts to achieve sustained competitive advantage.

2.1 Resource-Based View (RBV)

The Resource-Based View (RBV) is a foundational theory in strategic management that posits organizational success is primarily determined by the ability to acquire, develop, and deploy internal resources that are valuable, rare, inimitable, and non-substitutable (VRIN) [15]. In the context of university-based Techno Parks, RBV provides a critical lens through which to examine how institutions leverage their unique resource configurations to achieve digital transformation and sustain innovation [16].

Techno Parks embedded within higher education institutions possess a distinctive set of resources, including academic expertise, research infrastructure, intellectual property, and collaborative networks [17]. These resources, when strategically aligned with digital initiatives, can serve as catalysts for innovation, entrepreneurship, and regional development [18]. For instance, the integration of digital platforms for knowledge sharing, virtual incubation, and smart infrastructure enhances the capacity of Techno Parks to support startups and spin-offs, thereby reinforcing their role as engines of economic and technological advancement [19].

Moreover, RBV emphasizes the importance of resource orchestration how institutions mobilize and coordinate their assets to respond to environmental changes. In the digital age, this involves not only investing in technological infrastructure but also cultivating human capital with digital competencies, fostering a culture of innovation, and establishing governance mechanisms that support agile decision-making. The ability to reconfigure existing resources to meet emerging challenges is essential for maintaining competitiveness and relevance in rapidly evolving innovation ecosystems [20].

In applying RBV to the study of digital strategy adaptation in Techno Parks, this research highlights the strategic imperative for higher education institutions to identify and enhance their core capabilities [21]. These include digital infrastructure, data management systems, interdisciplinary research teams, and external partnerships [22]. By doing so, institutions can transform their Techno Parks into digitally empowered hubs that contribute meaningfully to sustainable development goals (SDGs), particularly those related to quality education (SDG 4), industry and innovation (SDG 9), and partnerships (SDG 17) [23].

2.2 Dynamic Capabilities Theory

Dynamic Capabilities Theory offers a critical extension to the Resource-Based View by emphasizing the strategic processes through which organizations adapt, integrate, and reconfigure their internal and external resources in response to rapidly changing environments [24]. In the context of university-based Techno Parks, this theoretical perspective is particularly relevant, as these institutions operate within increasingly volatile and complex innovation ecosystems shaped by digital disruption, policy shifts, and evolving stakeholder expectations [25].

The concept of dynamic capabilities encompasses three core dimensions: sensing, seizing, and transforming [26]. Sensing refers to the institution's ability to identify emerging technological trends, market opportunities, and societal needs [27]. This involves environmental scanning, stakeholder dialogue, and anticipatory learning, which are essential for recognizing the potential of digital technologies such as artificial intelligence, blockchain, and cloud computing [28]. Seizing involves the mobilization of resources and the execution of strategic decisions to capture value from identified opportunities [29]. For Techno Parks, this may include investing in digital infrastructure, launching new incubation programs, or forming cross-sectoral partnerships that enhance innovation capacity [30]. Transforming refers to the organizational agility required to reconfigure structures, processes, and cultures to support sustained innovation [31]. This includes redesigning governance models, fostering interdisciplinary collaboration, and embedding digital literacy across academic and administrative units [32].

In applying Dynamic Capabilities Theory to the study of digital strategy adaptation, it becomes evident that Techno Parks must cultivate institutional agility and learning capacity to remain

competitive and relevant [33]. The ability to continuously evolve in response to technological and societal changes is not merely a technical challenge but a strategic imperative [34]. Institutions must develop mechanisms for feedback, experimentation, and iterative improvement, enabling them to refine their digital strategies and align them with long-term sustainability goals [35].

Furthermore, dynamic capabilities are closely linked to the concept of absorptive capacity the ability to recognize the value of new information, assimilate it, and apply it to commercial ends [36]. In the context of higher education, this translates into the capacity to integrate academic research with entrepreneurial practice, thereby enhancing the impact of Techno Parks on regional development and global innovation agendas [37].

2.3 Dynamic Capabilities Theory

The integration of strategic management principles and innovation ecosystem theory provides a comprehensive framework for understanding how university-based Techno Parks can effectively adapt digital strategies to enhance institutional performance and societal impact [38]. Strategic management focuses on the deliberate alignment of organizational resources, capabilities, and external opportunities to achieve long-term objectives [39]. In the context of Techno Parks, this involves formulating and executing digital strategies that are coherent with the mission of the host university, responsive to technological trends, and attuned to the needs of diverse stakeholders [40].

Techno Parks operate within complex and dynamic environments that require strategic foresight and adaptive governance [41]. The formulation of digital strategies must consider both internal factors such as organizational culture, leadership commitment, and resource availability and external drivers, including policy frameworks, market dynamics, and technological disruptions [42]. Effective strategic management enables Techno Parks to navigate these complexities by setting clear priorities, allocating resources efficiently, and fostering a culture of innovation and continuous improvement [43].

Complementing strategic management, the concept of innovation ecosystems emphasizes the interdependence among various actors universities, startups, industry partners, government agencies, and civil society who collectively contribute to the generation, diffusion, and application of knowledge [44]. Techno Parks serve as orchestrators within these ecosystems, facilitating collaboration, knowledge exchange, and co-creation across disciplinary and sectoral boundaries [45]. The success of digital transformation initiatives within Techno Parks depends not only on internal capabilities but also on the strength and diversity of their external linkages [46].

Innovation ecosystems are characterized by openness, adaptability, and shared value creation. Digital technologies play a pivotal role in enabling these characteristics by providing platforms for virtual collaboration, data sharing, and real-time communication [47]. By strategically embedding digital tools into their operations, Techno Parks can enhance connectivity among ecosystem participants, reduce transaction costs, and accelerate innovation cycles. Moreover, digital strategies can support inclusive participation by enabling access to resources and opportunities for underrepresented groups, thereby contributing to the broader goals of equity and sustainability [48].

2.4 Integration with Sustainable Development Goals (SDGs)

The integration of digital strategies within university-based Techno Parks aligns closely with the global agenda for sustainable development, as articulated in the United Nations Sustainable Development Goals (SDGs) [49]. These goals provide a comprehensive framework for addressing interconnected challenges related to education, innovation, infrastructure, and inclusive economic growth [50]. By embedding sustainability principles into digital transformation initiatives, Techno Parks can serve as strategic instruments for advancing multiple SDGs simultaneously [51].

One of the most direct linkages is with SDG 4: Quality Education, which emphasizes inclusive and equitable access to lifelong learning opportunities [52]. Techno Parks contribute to this goal by facilitating the commercialization of academic research, supporting digital learning platforms, and providing experiential learning environments for students and researchers [53]. The adoption of digital technologies enhances the accessibility and scalability of educational resources, enabling broader participation in innovation-driven activities [54].

SDG 9: Industry, Innovation and Infrastructure is also central to the mission of Techno Parks [55]. These entities act as incubators for technological advancement, supporting startups, spin-offs, and collaborative research initiatives that drive industrial modernization [56]. The strategic deployment of digital tools such as cloud computing, big data analytics, and smart infrastructure strengthens the capacity of Techno Parks to foster

resilient innovation ecosystems [57]. Moreover, digital strategies enable more efficient resource utilization, improved operational transparency, and enhanced connectivity among stakeholders, all of which contribute to sustainable industrial development [58].

In addition, SDG 17: Partnerships for the Goals underscores the importance of multi-stakeholder collaboration in achieving sustainable outcomes [59]. Techno Parks inherently operate within complex networks that include universities, private enterprises, government agencies, and civil society organizations [60]. Digital platforms facilitate these partnerships by enabling real-time communication, data sharing, and joint problem-solving [61]. The strategic integration of digital technologies thus enhances the effectiveness and inclusivity of collaborative efforts, promoting shared value creation and long-term impact [62].

3. METHODOLOGY

This study employed a systematic literature review (SLR) methodology to explore the strategic adaptation of digital technologies within university-based Techno Parks. The review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological transparency, rigor, and reproducibility.

3.1 PRISMA 2020 Framework Application

This study employed a systematic literature review (SLR) methodology to explore the strategic adaptation of digital technologies within university-based Techno Parks. The review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological transparency, rigor, and reproducibility.

A total of 41,386 records were identified through the Scopus database. Following the removal of 31,152 duplicate records, 10,234 unique records were screened based on titles and abstracts. Articles were excluded if they lacked relevance to digital strategy in university-based Techno Parks, resulting in 9,846 exclusions.

Subsequently, 388 full-text reports were sought for retrieval. However, 210 reports could not be accessed due to availability constraints. The remaining 178 articles underwent full-text eligibility assessment. Of these, 51 articles were excluded due to reasons such as irrelevance (n = 20), publication type (conference proceedings, n = 23; books, n = 8). Ultimately, 127 studies met the inclusion criteria and were incorporated into the final synthesis.

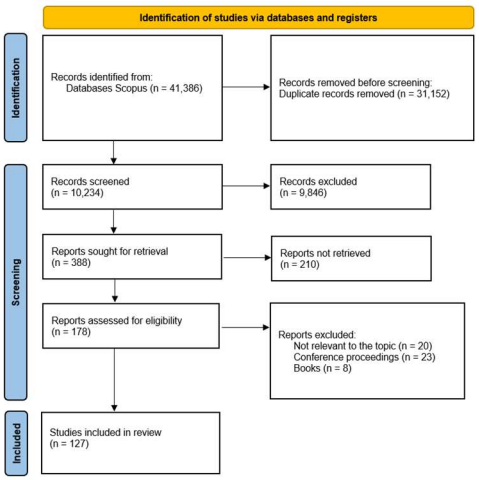

Figure 1. PRISMA flow diagram of the study

3.2 Screening and Quality Assessment

The screening process was conducted in multiple stages to ensure the inclusion of high-quality and thematically relevant studies. The initial dataset comprised 41,386 records retrieved from the Scopus database. After removing 31,152 duplicate entries, 10,234 records remained for title and abstract screening. At this stage, 9,846 records were excluded due to lack of relevance to digital strategy in university-based Techno Parks.

Following the initial screening, 388 articles were selected for full-text retrieval. However, 210 articles were inaccessible due to availability limitations. The remaining 178 articles were assessed for eligibility based on thematic relevance, methodological rigor, and publication type. A total of 51 articles were excluded: 20 were deemed irrelevant, 23 were conference proceedings, and 8 were books. The final selection consisted of 127 studies that met all inclusion criteria.

Each article was evaluated against a set of quality criteria, including peer-reviewed status, publication in English, full-text availability, direct relevance to digital strategy in higher education Techno Parks, and clarity in research design and theoretical framework. The screening process and applied quality criteria at each stage are summarized in Table 2.

Table 2: A summary of the screening process and quality criteria.

Stage	Count	Quality Criteria for Inclusion
Records identified from Scopus	41,386	
Duplicate records removed	31,152	
Records screened	10,234	Peer-reviewed, English language, full-text available
Records excluded	9,846	Not relevant to digital strategy in Techno Parks
Reports sought for retrieval	388	Accessible full-text reports
Reports not retrieved	210	Unavailable full-text
Reports assessed for eligibility	178	Direct relevance to digital strategy in HEI Techno Parks
Reports excluded	51	Irrelevant (20), Proceedings (23), Books (8)
Studies included in review	127	Meets thematic relevance and quality standards

3.3 Thematic Synthesis Approach

Thematic synthesis was employed as the primary method for analyzing the selected studies. This approach enabled the identification of patterns, relationships, and conceptual insights across diverse literature related to digital strategy adaptation in university-based Techno Parks.

The synthesis process was conducted in three structured phases. The first phase involved the extraction and coding of relevant data from each article. Key concepts, findings, and strategic elements were systematically coded using qualitative analysis software to ensure consistency and traceability.

The second phase focused on the development of descriptive themes. Coded data were grouped into broader categories that reflected recurring topics such as digital infrastructure, stakeholder engagement, governance mechanisms, and innovation support systems. These themes provided a foundation for understanding the operational and strategic dimensions of digital transformation.

The third phase involved the generation of analytical themes. These higher-order interpretations were derived by examining the relationships between descriptive themes and aligning them with the theoretical framework of the study. The Resource-Based View and Dynamic Capabilities Theory were used to interpret how institutions leverage internal resources and adapt to external changes to achieve sustainable innovation outcomes.

4. RESULT

This section presents the findings of the systematic literature review, structured according to the four research questions (RQ1–RQ4). The analysis is based on thematic synthesis of 127 peer-reviewed articles and integrates both descriptive and analytical insights aligned with the theoretical framework.

4.1 RQ1: Digital Strategies Employed in Techno Parks

The review identified a diverse array of digital strategies currently employed within university-based Techno Parks. The most prominent technologies include Artificial Intelligence (AI), Cloud Computing, Big Data Analytics, and the Internet of Things (IoT). AI was discussed in 42 articles, highlighting its use in predictive analytics, intelligent automation, and machine learning for research commercialization. Cloud Computing appeared in 36 articles, enabling scalable infrastructure and remote collaboration. Big Data Analytics was featured in 33 articles, supporting performance monitoring and strategic forecasting. IoT was mentioned in 16 articles, facilitating smart infrastructure and real-time data collection. These technologies are often integrated into broader digital ecosystems, reflecting a shift toward intelligent, adaptive, and data-centric environments that support innovation and sustainability.

Table 3: Summary of Digital Technologies and Their Functions in Techno Parks

Technology	Function in Techno Parks	Frequency in Literature
Artificial Intelligence	Predictive analytics, automation, smart systems	44
Cloud Computing	Remote collaboration, scalable infrastructure	36
Big Data Analytics	Strategic forecasting, performance monitoring	33
Internet of Things	Smart infrastructure, real-time data collection	16

4.2 RQ2: Challenges in Implementing Digital Strategies

The implementation of digital strategies in Techno Parks faces several organizational, technological, and ecosystem-related challenges. Infrastructural limitations, such as outdated systems and lack of connectivity, were frequently cited.

Digital skill gaps among staff and stakeholders hinder effective utilization of technologies. Organizational inertia, including resistance to change and siloed departments, impedes strategic alignment. Governance challenges, such as rigid decision-making structures, limit agility. These barriers underscore the need for capacity building, leadership commitment, and adaptive governance to ensure successful digital transformation.

Table 4: Summary of Digital Technologies and Their Functions in Techno Parks

Challenge Type	Description	Frequency in Literature	Reference
Infrastructural	Limited digital infrastructure and connectivity	High	[63 – 65]
Skill Gap	Lack of digital competencies among staff	Medium	[66 – 69]
Organizational Culture	Resistance to change, siloed departments	Medium	[69 – 71]
Governance	Lack of agile decision-making frameworks	Low	[72 – 76]

4.3 RQ3: Strategic Adaptation through RBV and Dynamic Capabilities

The findings demonstrate that Techno Parks strategically adapt digital technologies through mechanisms explained by the Resource-Based View (RBV) and Dynamic Capabilities Theory. RBV highlights the role of VRIN resources such as digital infrastructure, research expertise, and intellectual property in driving innovation. Dynamic Capabilities Theory emphasizes the processes of sensing, seizing, and transforming. Techno Parks exhibit sensing through environmental scanning and stakeholder feedback, seizing through investment in digital platforms and partnerships, and transforming through agile restructuring and digital literacy initiatives. These capabilities enable institutions to reconfigure resources and align digital strategies with evolving opportunities and sustainability goals.

Table 5: Mapping RBV and DCT Concepts to Techno Park Practices

Theoretical Concept	Practical Application in Techno Parks	Reference
RBV – VRIN Resources	AI platforms, research infrastructure	[77 – 79]
RBV – Resource Orchestration	Cross-functional teams, digital governance	[80 – 82]
DCT – Sensing	Environmental scanning, stakeholder feedback	[83 – 85]
DCT – Seizing	Launching digital incubators, partnerships	[86 – 88]
DCT – Transforming	Agile restructuring, digital literacy programs	[89 – 91]

4.4 RQ4: Contributions to Sustainable Development Goals (SDGs)

Digital strategies within Techno Parks contribute significantly to the achievement of SDGs. SDG 4 (Quality Education) is supported through digital learning platforms and experiential environments. SDG 9 (Industry, Innovation and Infrastructure) is advanced via smart infrastructure and data-driven innovation. SDG 17 (Partnerships for the Goals) is facilitated by digital platforms that enable multi-stakeholder collaboration. Additionally, digital strategies promote environmental sustainability through energy-efficient systems and AI-based environmental modeling. These contributions position Techno Parks as strategic instruments for achieving inclusive and sustainable development.

Table 6: Alignment of Digital Strategies with SDGs

SDG Target	Digital Strategy Contribution	Example Practice	Reference
SDG 4	Enhancing access to education via digital platforms	Virtual incubation, e-learning	[92 – 94]
SDG 9	Supporting industry and innovation through smart systems	AI for commercialization, IoT campus	[95 – 97]
SDG 17	Enabling partnerships via digital collaboration tools	Open innovation platforms, joint R&D	[98 – 100]

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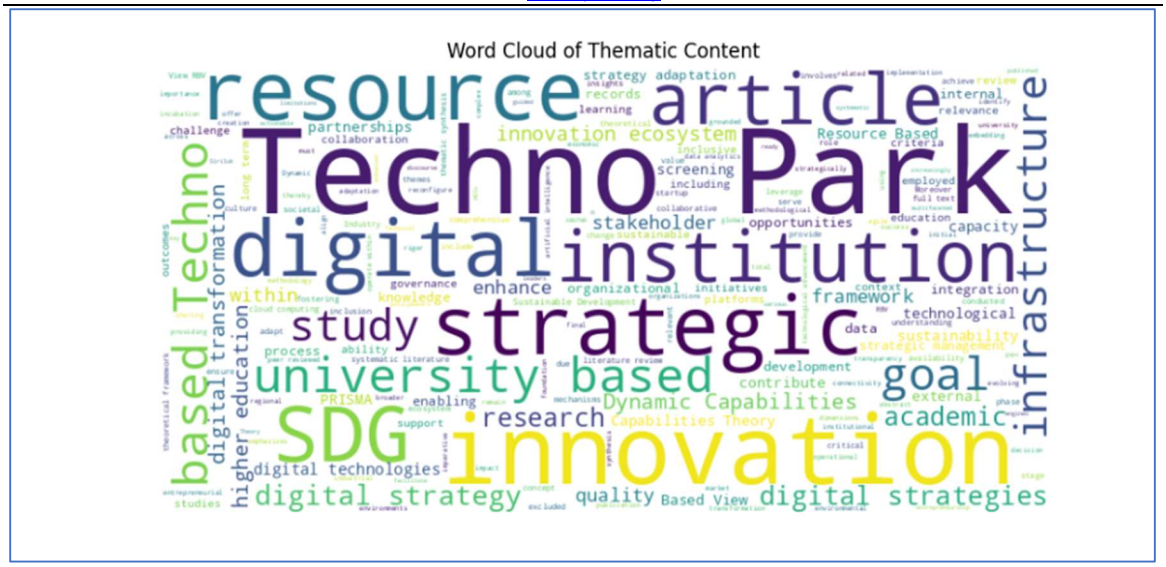

Figure 2. Word cloud of thematic content

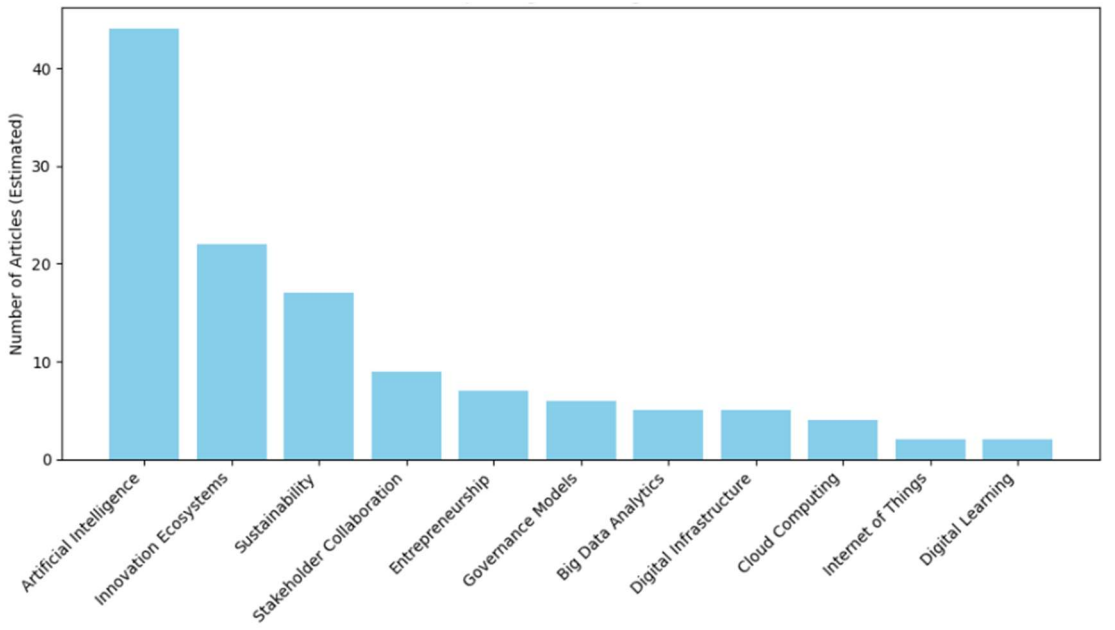

Figure 3. The thematic map of digital strategies in Techno Park

5. DISCUSSION

The findings of this systematic review provide a comprehensive understanding of how university-based Techno Parks are adapting digital strategies to foster innovation and sustainability. The discussion is structured around three key dimensions: theoretical integration, contextual variation, and future research directions.

5.1 Integration with Theoretical Frameworks

The findings of this review demonstrate a strong theoretical alignment with both the Resource-Based View (RBV) and Dynamic Capabilities Theory, which were employed as the conceptual foundation for analyzing digital strategy adaptation in university-based Techno Parks.

From the RBV perspective, the frequent implementation of technologies such as artificial intelligence, cloud computing, and big data analytics reflects the strategic utilization of valuable, rare,

inimitable, and non-substitutable (VRIN) resources. These digital assets are not merely operational tools but are leveraged as core capabilities that differentiate Techno Parks and enhance their innovation potential. For example, AI-driven platforms for research commercialization and smart infrastructure systems exemplify how digital resources are embedded into institutional strategy to generate sustained competitive advantage.

In parallel, the review highlights the relevance of Dynamic Capabilities Theory, particularly in the context of organizational agility and strategic responsiveness. The presence of agile governance models, stakeholder engagement mechanisms, and absorptive capacity illustrates how Techno Parks are able to sense, seize, and transform in response to technological and societal shifts. Institutions that exhibit high levels of dynamic capabilities are better equipped to reconfigure internal processes, integrate external knowledge, and align digital initiatives with long-term sustainability goals.

Moreover, the thematic synthesis revealed that successful digital transformation is not solely dependent on resource possession but on the strategic orchestration and renewal of those resources. This reinforces the theoretical proposition that dynamic capabilities are essential for maintaining relevance in rapidly evolving innovation ecosystems.

5.2 Regional and Institutional Variations

The synthesis of 127 studies revealed significant variations in digital strategy adaptation across different geographic regions and types of higher education institutions (HEIs). These contextual differences influence not only the choice of technologies but also the strategic priorities, implementation models, and sustainability outcomes of university-based Techno Parks.

5.2.1 Regional and Institutional Variations

Techno Parks in high-income countries, particularly in Western Europe, North America, and parts of East Asia, tend to adopt advanced and capital-intensive technologies such as artificial intelligence, big data analytics, and digital twins. These regions benefit from well-established digital infrastructure, strong public-private partnerships, and supportive national innovation policies. The focus in these contexts is often on enhancing global competitiveness, accelerating research commercialization, and integrating digital strategies into national smart specialization agendas.

In contrast, Techno Parks in emerging economies notably in Southeast Asia, Latin America, and parts of Africa prioritize scalable, cost-effective, and inclusive digital solutions. Cloud computing, mobile platforms, and open-source tools are more prevalent in these regions, reflecting both resource constraints and the need to expand access to innovation opportunities. The emphasis is often placed on digital literacy, entrepreneurship support, and regional development, with sustainability framed in terms of social inclusion and capacity building.

5.2.2 Institutional Differences

Variation is also evident across different types of HEIs. Research-intensive universities typically integrate digital strategies into interdisciplinary research clusters, smart campus initiatives, and technology transfer offices. These institutions are more likely to align digital transformation with long-term innovation missions and global rankings.

In contrast, teaching-focused or regional universities often adopt digital strategies to enhance student engagement, support local entrepreneurship, and strengthen community partnerships. Their Techno Parks tend to emphasize digital learning platforms, virtual incubation, and applied research with immediate societal relevance.

Furthermore, public universities are more likely to align their digital strategies with national development goals and SDGs, while private institutions may focus on market-driven innovation and competitive differentiation.

5.2.3 Implications

These variations underscore the importance of context-sensitive digital strategies. A one-size-fits-all approach is unlikely to succeed. Instead, digital transformation in Techno Parks must be tailored to institutional missions, regional capabilities, and stakeholder expectations. Recognizing and leveraging these contextual differences can enhance the effectiveness, equity, and sustainability of digital innovation ecosystems.

5.3 Regional and Institutional Variations

While this systematic review provides a comprehensive synthesis of digital strategy adaptation in university-based Techno Parks, several gaps remain that warrant further investigation. Addressing these gaps will not only deepen theoretical understanding but also enhance the practical relevance of future research in this domain.

5.3.1 Longitudinal and Impact-Oriented Studies

Most of the reviewed literature focuses on cross-sectional analyses or conceptual frameworks. Future

research should adopt longitudinal designs to examine how digital strategies evolve over time and how they influence innovation performance, stakeholder engagement, and sustainability outcomes. Tracking digital transformation trajectories across multiple years would provide insights into institutional learning, strategic recalibration, and long-term impact.

5.3.2 Comparative Regional and Institutional Case Studies

Given the contextual variations identified in this review, future studies should conduct comparative case studies across regions and types of institutions. For example, exploring how Techno Parks in Southeast Asia differ from those in Western Europe in terms of governance, resource mobilization, and stakeholder dynamics would offer valuable lessons. Similarly, comparing research-intensive universities with teaching-focused institutions could reveal differentiated pathways of digital strategy implementation.

5.3.3 Exploration of Emerging Technologies

While AI, cloud computing, and big data are well-represented in current literature, emerging technologies such as blockchain, digital twins, edge computing, and generative AI remain underexplored in the context of Techno Parks. Future research should investigate how these technologies can be integrated into academic innovation ecosystems and what governance models are required to support their adoption.

5.3.4 Policy and Governance Research

There is limited research on the role of national innovation policies, funding mechanisms, and regulatory frameworks in shaping digital strategy adoption. Future studies should examine how macro-level governance influences micro-level institutional behavior, particularly in resource-constrained settings. This line of inquiry could inform policy design that supports equitable and scalable digital transformation.

5.3.5 Stakeholder-Centered and Participatory Approaches

Finally, future research should incorporate stakeholder-centered methodologies, including participatory action research, co-design workshops, and ethnographic studies. Understanding the lived experiences of students, entrepreneurs, faculty, and administrators can reveal hidden barriers and enablers of digital transformation, leading to more inclusive and context-sensitive strategies.

5.4 Practical Implications

This review offers actionable insights for university leaders, policymakers, and practitioners. Institutions should prioritize agile governance mechanisms that enable timely decision-making, foster stakeholder collaboration through digital platforms, and invest in building absorptive capacity to bridge digital skill gaps. Policymakers can draw upon these findings to design supportive frameworks that link Techno Parks with national innovation and sustainability agendas.

While this systematic review provides comprehensive coverage of recent literature, several limitations remain. The reliance on secondary sources restricts empirical validation of specific practices, and cross-sectional studies dominate the current evidence base. Longitudinal data and comparative case studies would be valuable to assess the long-term effects of digital strategy adaptation. Furthermore, emerging technologies such as blockchain, digital twins, and generative AI remain underexplored, leaving opportunities for future inquiry.

6. DIFFERENTIATION FROM PRIOR STUDIES

Unlike previous studies that often examined individual technologies or localized contexts, this work provides a comprehensive synthesis across 127 peer-reviewed articles, integrating insights from the Resource-Based View and Dynamic Capabilities Theory. The study uniquely highlights how university-based Techno Parks adapt digital strategies not only to enhance innovation but also to contribute directly to multiple Sustainable Development Goals. This dual theoretical and policy-oriented perspective differentiates the present work and underscores its broader relevance.

7. OPEN PROBLEMS AND FUTURE RESEARCH ISSUES

Several unresolved questions remain. Future research should examine the longitudinal impacts of digital strategy adaptation, as current evidence is largely cross-sectional. Comparative studies across regions and institutional types would enrich understanding of contextual variations. Moreover, the integration of emerging technologies such as blockchain, digital twins, and generative AI warrants further exploration. Finally, the role of national innovation policies and governance frameworks in enabling equitable digital transformation remains an open area of research.

8. CONCLUSION

This study contributes to the literature in three major ways. First, it integrates the Resource-Based View and Dynamic Capabilities Theory into a systematic review of digital strategy adaptation in university-based Techno Parks. Second, it provides practical implications for higher education leaders and policymakers seeking to build resilient and future-ready innovation ecosystems. Third, it advances policy debates by linking digital transformation explicitly to the Sustainable Development Goals.

In doing so, this article adds significantly to the body of knowledge by moving beyond technology-centric analyses toward a strategic and theoretically grounded framework for understanding digital transformation in higher education innovation ecosystems. This framework offers both conceptual clarity for scholars and actionable guidance for practitioners.

The findings reveal that artificial intelligence, cloud computing, and big data analytics are the most prominent technologies driving innovation in Techno Parks. However, their impact is contingent upon enabling factors such as agile governance, resource orchestration, and absorptive capacity. The review also underscores the importance of ecosystem collaboration, where multi-stakeholder partnerships and knowledge exchange mechanisms serve as catalysts for inclusive and sustainable innovation.

Contextual variations across regions and institutional types further emphasize the need for tailored digital strategies. High-income regions tend to focus on advanced technologies and global competitiveness, while emerging economies prioritize scalable solutions and social inclusion. Similarly, research-intensive universities adopt long-term innovation agendas, whereas teaching-focused institutions emphasize entrepreneurship and community engagement.

In light of these insights, future research should explore longitudinal impacts, comparative case studies, and quantitative assessments of sustainability outcomes. Emerging technologies and policy frameworks also warrant deeper investigation to inform strategic planning and institutional design.

Ultimately, university-based Techno Parks hold significant potential as transformative agents in the digital era. By strategically integrating digital resources with organizational capabilities and ecosystem partnerships, these institutions can advance sustainable development and redefine the role of higher education in innovation-driven societies.

9. AUTHOR CONTRIBUTIONS

Siriluk Phuengrod conceptualized the research topic, conducted the comprehensive literature review, synthesized relevant information, analyzed the evaluation results, and was responsible for writing the entire manuscript, including drafting the introduction, methodology, results, and discussion sections. Pinyaphat Tasatanattakool managed the manuscript formatting to comply with the journal's specific requirements and oversaw the submission process. Prachyanun Nilsook provided consultation throughout the research process, offering insights and guidance on key aspects of the study. All authors reviewed and approved the final version of the manuscript.

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